# The Open University of Sri Lanka
# Faculty of Engineering Technology

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| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| Course Code and Title | : **DMX5210/DMX6532- Vehicle Dynamics and Design of Automotive Components** |
| Academic Year | : 2021/22 |
| Date | : 3rd February 2022 |
| Time | :14.00 – 17.00 Hrs |

***READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE QUESTION PAPER***

**Instructions.: This question paper consists of seven (07) questions. You are required to answer any six (06) questions. All questions carry equal marks.**

Question 01

An ultimate analysis of a liquid fuel (oil) by mass is Carbon (C) 78% and Hydrogen(H2) 22%. assuming that air contain 23% of oxygen by mass, if one kg of fuel is burnt, determine

mass of CO2 produced, mass of H2O produced, mass of oxygen required to burn the fuel, mass of air required to burn one Kg of fuel and Mass of combustion products.

Question 02

A single plate clutch having a single driving plate with contact surfaces on each side is required to transmit 45 kW at 6500 r.p.m. The ratio of inner radius to outer radius 0.8 The coefficient of friction is 0.4. Assuming a uniform pressure of 0.21 N/mm$^2$ design the clutch with a single disc having contact surfaces on either side.

Question 03

The length of the connecting rod and the crank radius for a typical automotive engine are 230 mm and 120 mm respectively.

Determine the velocity and acceleration of the piston when the engine is rotating at 2400 rev/min.

Determine the position with respect to BDC, where the piston attains a zero acceleration.

Question 04

A typical torque variation for an engine is given in figure Q4.

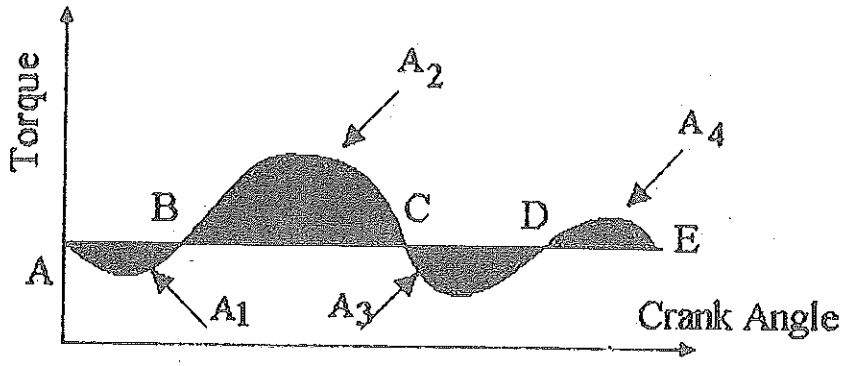


Figure Q4 - torque variation for an engine

The enclosed areas are A1 = 670 J A2 = 1400 J A3 = 790 J A4 = 60 J it is necessary to keep the speed within the range 3400 to 3600 rev/min and the radius of gyration of the flywheel to be 0.4 m.

Determine

a. the coefficient of fluctuation of speed
b. the coefficient of fluctuation of energy
c. moment of inertia
d. mass of the flywheel

Question 05

a. Explain the broad are a of Noise Vibration and Harshness and what can be done to improove the ride comfort by reducing the harshness of a ride.
b. A car has a natural frequency of single degree of freedom in a vertical direction of 21 rad/s is driven over a road surface consists of sine waves whose distance apart is 28 m and whose amplitude is 0.08m. Determine the velocity at which the resonance will occur

Question 06

a. Tyres are made to grip the road surface when the vehicle being steered, accelerated or braked. Name and explain the parameter that affects this behaviour.
b. Certain resistance is being offered by the road surface on to the rotating wheel during rolling of the vehicle, name the parameter that describes this behaviour and explain how this phenomena occur.
c. Explain what is ride and handling

Question 07

Following information is given for a vehicle which is negotiating a 14 degree gradient with a constant velocity of 30 km/h

| | | |
|---|---|---|
| Mass of the truck | - | 1250 kg |
| Tractive resistance against the motion | - | 0.2 N/kg |
| Diameter of the road wheel | - | 1.3 m |
| Engine speed | - | 1,800 rev/min |
| Transmission efficiency of the truck | - | 0.85 |

a. Determine the power required

b. Determine the overall transmission ratio between the engine and the road wheels

c. When the engine transmitting three times the power calculated in (a) at 1,200 rev/min, with the throttle at fully open position determine:

   i. The maximum truck speed along a $10^0$ slope

   ii. The overall gear ratio required.

THE OPEN UNIVERSITY OF SRI LANKA

VEHICLE DYNAMICS AND DESIGN OF AUTOMOTIVE COMPONENTS

Data Sheet

*1. Wear Tooth Load for gears*

$W_w = D_p . b . Q . K$

where $W_w$ = Maximum or limiting load for wear in newtons.
$D_p$ = Pitch circle diameter of the pinion in mm,
b = Face width of the pinion in mm,
Q = Ratio factor

$$= \frac{2 \times V.R}{V.R + 1} = \frac{2T_G}{T_G + T_P}, \text{ for external gears}$$

$$= \frac{2 \times V.R}{V.R - 1} = \frac{2T_G}{T_G + T_P}, \text{ for internal gears.}$$

V.R. = Velocity ratio = $T_G / T_p$,
K = Load-stress factor (also known as material combination factor) in $N/mm^2$.

**2. The thickness of a cylinder wall**

The thickness of a cylinder wall (t) is usually obtained by using a thin cylindrical formula, i.e.

$$t = \frac{p \times D}{2\sigma_c} + C$$

where
p = Maximum pressure inside the cylinder in $N/mm^2$,
D = Inside diameter of the cylinder or cylinder bore in mm,
$\sigma_c$ = Permissible circumferential or hoop stress for the cylinder material in MPa or $N/mm^2$.
C = Allowance for re-boring.

The allowance for re-boring (C ) depending upon the cylinder bore (D) for I. C. engines is given in the following table:

| *D* (mm) | 75 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| *C* (mm) | 1.5 | 2.4 | 4.0 | 6.3 | 8.0 | 9.5 | 11.0 | 12.5 | 12.5 | 12.5 |

*3. Design of Cylinder Head*

The cylinder head may be approximately taken as a flat circular plate whose thickness ($t_h$) may be determined from the following relation:

$$t_h = D\sqrt{\frac{C.p}{\sigma_c}}$$

where

D – Cylinder bore in mm,
p - Maximum pressure inside the cylinder in N/mm$^2$,
$\sigma_c$ - Allowable circumferential stress in MPa or N/mm$^2$. It may be taken as 30 to 50 MPa,
C - Constant whose value is taken as 0.1.

*4. Design of the Piston Crown*

**The thickness of the piston head for strength**

The thickness of the piston head ($t_H$), according to Grashoff's formula is given by

$$t_H = \sqrt{\frac{3p.D^2}{16\sigma_t}} (\text{in mm})$$

Where,

p = Maximum gas pressure or explosion pressure in N/mm$^2$,
D = Cylinder bore or outside diameter of the piston in mm, and
$\sigma_t$ = Permissible tensile stress for the material of the piston in MPa or N/mm$^2$

**Design of piston head for heat transfer**

On the basis of second consideration of heat transfer

$$t_H = \frac{H}{12.56k(T_C - T_E)} (\text{in mm})$$

**5. Design Against fatigue**

Gerber method

$$\frac{1}{F.S} = \left(\frac{\sigma_m}{\sigma_u}\right)^2 F.S. + \frac{\sigma_v \times K_f}{\sigma_e}$$

The Goodman criteria

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v \times K_f}{\sigma_e}$$

The Soderberg criteria

$$\frac{1}{F.S.} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v \times K_f}{\sigma_e}$$

where F.S. = Factor of safety,
$\sigma_m$ = Mean stress.
$\sigma_u$ = Ultimate stress,
$\sigma_v$ = Variable stress.
$\sigma_e$ = Endurance limit for reversed loading,
$K_f$ = Fatigue stress concentration faction